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AUTHOR Bainer, Deborah L.; Wright, Dinah
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ABSTRACT

When a constructivist professional development program was introduced to elementary teachers in a school district, some of the teachers who teach in self-contained classrooms (N=59) elected to participate in a yearlong professional development project. To explore the impact of professional development, a purposive sample of participating teachers was selected and interviewed in depth one year following the professional development program. The questions focus on the long-range impact of the professional development program on science instruction in classrooms, on the teachers' attitudes toward science teaching and learning, and the barriers that they perceive to science education reform at the building and district levels. Teachers were observed and interviewed on site, student-developed artifacts were examined, and an on site focus group was conducted. Results suggest that when given the freedom to make choices about their own professional development, teachers construct programs which lead to changes in their thinking about teaching and learning. (Author/DDR)

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Teacher Choices about their own Professional Development in Science Teaching and Learning

Presenters:

Deborah L. Bainer, Ph.D.
Associate Professor
The Ohio State University, Mansfield
1680 University Drive
Mansfield, OH 44906
Office: 419/755-4287
email: bainer.1@osu.edu

D Bainer

Dinah Wright, Ph.D.
Scottish Corners Elementary School
5950 Sells Mill Drive
Dublin, OH 43017
School: 614/764-5963
email: wright_dinah@msmail.dublin.k12.oh.us
Dublin City School District

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Teacher Choices about their Own Professional Development
in Science Teaching and Learning

The need for professional development of elementary teachers in science education is well documented. Elementary science teachers are poorly prepared to teach science by university preservice teacher education programs, lack sufficient content knowledge in science to interpret and teach even basic concepts, and are unaware of or reluctant to use effective instructional methods (Raizen & Michelsohn, 1994). Inservice teacher professional development programs therefore must target specific weaknesses in order to improve the quality and quantity of science education in elementary schools.

Notions of effective inservice education have changed in recent years. Generally, the literature does not support the use of short, one-shot workshops provided on an irregular basis by outsiders as a professional development approach. Rather, effective professional development programs are characterized by: a) the development of a coherent plan; b) in-depth and long-term programs such as intensive courses or institutes; c) substantial follow-up as teachers return to the classroom; d) a critical mass of teachers and/or administrators from one building or district to build internal support structures; and e) use of teachers in training and support roles (Loucks-Horsley, 1989).

Sparks (1994) identified three powerful ideas "altering the face of professional development in this decade" (p. 42). The first is the notion of *results-driven* professional development. This notion states that the effectiveness of professional development efforts must be judged by whether the program alters instruction in ways that benefit students rather than by how many teachers and administrators participate and how satisfied they are with the program. Honig (1994) points out that a problem with education reform is that it is not typically organized around improving teachers' knowledge of content or enhancing their ability to collaborate to improve instruction.

A second guiding notion is *systems thinking*, which recognizes the complex, interdependent interrelationships among various parts of the educational system. As suggested by professional development efforts in the 80s, a teacher-by-teacher strategy is not powerful enough to transform a school because 85% of the barriers to reform reside in the school's organization and process (Sparks, 1994). Collective, not individual, efforts which involve a critical mass of staff committed to improving student performance and making necessary instructional changes are needed to initiate systematic reform in science education.

A third notion driving professional development programs for the 90s is *constructivism*. Constructivism has long been applied as a theory for learning in children. It holds that individuals learn at different rates and through different modes. Because of these differences, students in any classroom will be at a variety of different levels in their developmental learning process. Constructivism further holds that learning is a social experience.

the district were above the state average for science (state = 59% pass rate; district = 79% for 1996; state = 58%, district = 79% for 1997) and for the five content area tests overall (state = 50%, district = 74% for 1996; state = 36%, district = 57% for 1997; the exam was changed for 1997 which resulted in lower scores overall).

Participants. When the constructivist professional development program was introduced to all 250 district elementary teachers in August 1995, 66 teachers elected to participate in the year-long project. Of these, 59 taught in self-contained classroom in grades K-5 throughout the nine elementary buildings in the district. Data from only these teachers is presented in this paper. Most of the teachers (54 out of 59) were females. Over half (35 teachers, or 59.3%) of the participating teachers taught in primary grades (K-3), while 21 (35.6%) taught intermediate grade levels (grades 4 and 5). The remaining three teachers (5.1%) taught in classrooms which were a 3/4 split.

To explore the impact of the professional development more closely, a purposive sample of participating teachers was selected and interviewed in depth one year following the professional development program (Spring 1997). In purposive sampling, participants are not selected randomly but rather with "logic and power" to provide "information-rich cases" (Patton, 1990) for the study. In this way, researchers can learn the most about the issues of concern. The elementary building with which the researchers were most familiar was selected for a closer look at the impact, costs, and benefits of the professional development program. The K-5 building has 25 teachers, of which 10 participated in the professional development program. Of these, eight teachers representing a range of grade levels and recommended by the science coordinator as most articulate agreed to participate. Questions focused on the long-range impact of the professional development program on science instruction in their classrooms and building, on their attitudes toward science teaching and learning, and barriers they perceived to science education reform at the building and district levels. Teachers were observed and interviewed on-site, student-developed artifacts were examined, and an on-site focus group was conducted.

Program. During the 1994-95 school year, a district-wide team of 15-18 teachers representing all elementary grades and buildings modified the district science course of study (COS) to comply with the new state framework. By Summer 1995, three members of the COS committee realized the need for teacher professional development in order to successfully implement the new COS. They proposed a plan focused on enhancing teachers' skills and content knowledge. Near the end of the summer, a university faculty member joined the team to facilitate program planning, gaining university credit, and identifying resources. Based on an analysis of the professional development needs expressed by the teachers, a menu of professional development opportunities was identified. The plan, to be implemented throughout the 1995-96 school year, required participating teachers to document at least 30 contact hours of professional development training and to submit a culminating authentic project reflecting their participation and growth.

The menu of professional development opportunities included a variety of options throughout the school year. These included five after-school, three-hour sessions presented by academicians. Topics, selected based on teacher needs, were concept development, inquiry-oriented lesson planning, earth systems approaches to science education, integrating children's literature into the science curriculum, and authentic assessment of science learning. An inservice day focused on grade-level science curriculum planning and a year-end session to debrief and share

how do they make those decisions?

This question deals with the type of professional develop experience which teachers constructed for themselves when given the opportunity to do so and how they made those choices.

At least half of the participating teachers chose to attend each of the after-school sessions throughout the year (lectures, inservice days, ERIC tour). The Saturday workshops were attended by 11 or 17 participating teachers each. However, 36 other workshops which they located by themselves were attended by participating teachers. Among the other activities chosen by teachers to enhance their science content knowledge were educational tours of the local zoo and the Center of Science and Industry (COSI), field trips, and science fairs. Table 1 shows activities which teachers chose for their professional development.

Table 1

The requirements for the culminating projects were loosely structured. They were, however, to be job-embedded to enable the researchers to observe what teachers chose as meaningful ways to demonstrate their professional growth across the year of their involvement in the project. Of the 59 projects collected, most were classified as resource books or lists for personal, team, or district use (26 projects, of 44.1%). Nineteen teachers (32.2%) demonstrated their growth by developing curricular unit plans. Others chose to write in-depth reflection papers of their teaching and learning in science instruction, to initiate a building-wide constructivist science fair, to conduct action research, to implement and evaluate new teaching methodologies, or to provide building-wide leadership in science education reform to demonstrate their growth. Of the 59 projects, 49 (83.1%) were directly and consciously related to the district curriculum by the teachers, nine were indirectly related, and one was purely for personal/professional growth but not related directly to the school curriculum or context. Table 2 summarizes the types of projects which teachers completed.

Table 2

When teachers were interviewed about how they selected experiences for their individualized professional development plans, the foremost criterion mentioned dealt with the nature of the experience; things which would benefit them professionally. That is, they chose experiences which met a professional need they identified about themselves (e.g., provided science content on a specific topic, provided networking experiences with other professionals, provided experience in leading hands-on science lessons, etc.), were an area of interest for them professionally (e.g., literature useful in teaching science, etc.) , or which reflected their learning style (e.g., level of structure, involvement, pace, and background required). The second criterion cited was if the topic was applicable or relevant to the teacher and what they were teaching at that grade level. Teachers chose experiences which "fit" with what they were doing already, but which enabled them to do those things better. The third criterion, mentioned

teacher stressed that she benefitted greatly from being engaged as a learner in science activities as part of the professional development experiences she chose. She experienced a range of emotions: pacing that was too fast sometimes and too slow at other times; frustration from not having sufficient time to complete activities; a casual attitude toward an apparently superficial activity until friendly competition developed among the teams. Taking this student perspective during activities enabled her to understand the experience her students would face when she led them in activities, and enabled her to adjust her instruction to reduce frustration and heighten motivation. As teachers watched their students engage in activity-based science, many gained respect for the young learners. "They are incredible thinkers," one teacher shared. "I had not given them enough credit before."

A third emergent theme was that the teachers viewed themselves as growing professionals; as professionals "in process" as a result of the choices they made during the professional development program. For some, the growth in science teaching skills was a relatively easy transfer of many of the strategies they already used in inductive language instruction. For others, the growth was more of a struggle, often conveyed with emotional words. Their descriptions of professional growth often showing a progression such as "dread, scary, reflective, then finally fun because I could see that students were excited and empowered." About half of the teachers expressed that they "need to keep growing" or, more optimistically, that while they are more confident with inquiry teaching, they "will be moreso in five more years!" As one teacher shared, "I'm growing, but I'm not a new person...yet!"

A fourth theme of change on the part of the teachers was a new sense of empowerment or freedom. One example of this was that they began to see themselves as needing to and now empowered to change their curriculum. While some became "100% sold" on the new curriculum which they "didn't buy into at first," all of the teachers clearly did not yet fully understand the new course of study. One teacher confessed that initially she dreaded the new curriculum, but through the professional development program she felt empowered by what the new curriculum approach could do for her and her students. "I realized that I was tired of frogs and toads and the other topics; I was renewed by the concepts in the new curriculum and how I could branch off of those topics into areas that were the kids' interests." Teachers also seemed to feel a new freedom in their ability to teach using a process approach in spite of their perceived weakness in science content. Two of the teachers discussed their feelings of inferiority because of their weak content background, then shared their realization that their lack of content was not a barrier when using a process approach. "I'm probably a better teacher without the science content," one confessed. "That way, I have to focus the kids on figuring it out for themselves!"

While these four themes suggest that the professional development program had a positive impact on the professional growth and attitudes of the teachers interviewed, a fifth somewhat disturbing theme also emerged from the data. That was an almost universal theme that they wanted to collaborate more with other teachers and to communicate more, especially about the new course of study. While some spoke of mentors or a science coordinator from whom they gathered ideas, most still felt isolated in their building rather than as part of a grade-level team. Many said it was because of a lack of time; others thought it was because they were "waiting for someone to take the initiative to get us talking with each other." While the professional development program

developing. Most teachers, though, talked of a different focus during assessment. Whereas before they looked at a product, now they were observing students as a way of assessing learning. They watched to see if students were making connections across concepts and ideas, and watched for changes in each individual child. One teacher summarized her new assessment as "...you have to watch the big picture. You have to see what they do (i.e., the product), but also observe and see what seems to be clicking."

4. When teachers make choices about their own professional development, what is their evaluation of this constructivist professional development approach?

This question focuses on teachers' advice and reactions to the year long professional development program and its impact on them and their school.

When queried about strengths and weaknesses of a professional development program presented over a year-long period which allowed teachers to construct their own learning experiences and to demonstrate their learning in meaningful ways, teachers were overwhelmingly positive. Foremost among the strengths they perceived was the fact that there were many options from which to choose. They liked to be able to "pick and choose things I needed." As one teacher explained, "If I could make the choice myself of whether or not I want to give up a Saturday (to attend a workshop) or not I don't mind doing it, but it's when you are dictated to that I mind. I guess that's where I also like a choice." Several teachers noted their appreciation for the variety offered by the program. There was a variety of speakers and facilitators, not "the same voice throughout." More important, the optional experiences were at a variety of levels so that teachers could make choices based on their expertise with hands-on science. Those who needed structure tended to build that into their professional development plans by attending the lectures because they were not yet ready for many of the loosely structured, inquiry-oriented options. Teachers also appreciated that most experiences were provided on-site rather than at the university. One teacher shared that on-site sessions enabled her to relax and learn more. "Bringing the course out to where the teachers are is the best gift you can give us" because teachers didn't have to rush from the school, to class, and back to their families.

A second strength of a constructivist professional development approach identified by the teachers was the time frame and flexibility. When commenting about having the program spread across the academic year, one teacher commented, "I love that...because I could reflect on everything that I was doing on my old units. I re-thought it. Is this a valuable thing to do, is it not, does this really tie in? Am I more skill oriented? What's the content there?...I was questioning some things and I was jotting some things down in a journal that I did. I wanted, I needed time to let it all soak in." This notion was reiterated across teachers: the year-long approach allowed teachers to work through new concepts and teaching methods more slowly and completely and to assimilate the changes into their teaching approach as they went along. Thus the changes in teaching and teacher growth were truly developmental. Teachers overwhelmingly voiced favor for the flexible time schedule because "it motivates me."

A third strength of the district-wide program was that it provided opportunities for networking. While many of the experiences provided opportunities for networking with professionals outside the network, more valued

assessed learning differently, changing the focus of assessment from judging products to watching for signs of growth and learning in individual students.

For most teachers, the constructivist approach to professional development was effective. The reasons they cited for its effectiveness support that a constructivist theory of learning applies to adult learners as well as it does to children. Teachers valued the opportunity to choose experiences which they needed and wanted to participate in. They valued a longer time frame in which to reflect upon and implement what they had learned. They valued the district-wide scope of the program because it provided networking and conversation about the science curriculum. These comments suggest that the program was effective in providing a climate for learning, as described by constructivist theory. Sadly, teacher laments that more communication and networking was still needed suggests that social learning, an essential element for a learning climate, was not sustained beyond the initial year of professional development, at least not at the level needed by some of the teachers.

This study provides suggestions for school districts engaging in professional development programs. Instructional change and education reform are possible only when teachers change the way they conceive of and think about teaching, learning, and learners. This study suggests that those changes in teacher thinking result when a constructivist approach is applied to professional development of adult learners. This requires districts to establish a climate for learning. Essential elements for this climate include implementing professional development across a period of time; at least across one year. This provides teachers with time for reflecting about and assimilating and accommodates different learning or developmental rates among teachers. Establishing this climate also requires that the professional development effort be at the building or, preferably, district level. This ensures that a critical mass of teachers will be involved in each building, thus providing opportunities for interaction, collaboration, and mutuality which make learning a social experience. Further, the climate requires that teachers are provided with a variety of options to reach and demonstrate the learning objectives or professional development. By thoughtfully developing individual plans based on a personal assessment of their professional needs, developmental level, and cognitive approach, teachers are able to maximize professional development.

This study suggests that, when given the freedom to make choices about their own professional development, teachers construct programs which do indeed lead to changes in their thinking about teaching and learning. Instructional change in the direction of "good science" is the result. How long these changes endure if the conditions for constructivist learning are not sustained, however, is open to question.

Table 1: Professional Development Experiences Chosen by Teachers

Experience	Participants (N=59)	% Total Participants	Total Time (Hours)
Structured Meetings:			
Concept Development	31	52.5	92
Lesson Planning	34	57.6	102
Earth Systems	42	71.2	125
Literature & Science	34	57.6	102
Assessment	25	42.3	75
Curriculum Planning Session	59	100.0	354
Debriefing/Sharing Session	46	78.0	137
ENC Tour	36	61.0	108
Workshops:			
Project Learning Tree	11	18.6	67
Project WET	17	28.8	102
Project WILD	11	18.6	80
Aquatic WILD	17	28.8	134
Other	36	61.0	161
Other Experiences:			
Zoo	6	10.2	21
COSI	8	13.6	29
Field trips	18	30.5	43
Science fair	11	18.6	121
Other	27	45.8	149

Table 2: Professional Development Projects Chosen by Teachers to Demonstrate Learning

Type of Project	Number of Projects	Percent of Projects
Resource Book or List	26	44.1
Curriculum Unit	19	32.2
Reflection Paper	6	10.2
Science Fair	3	5.1
Action Research	2	3.4
New Methodology	2	3.4
Instructional Leadership	1	.1